

2.0 PROJECT ALTERNATIVES

This section describes in detail the “No-Action” Alternative, the proposed action, other reasonable alternatives that were studied in detail, and alternatives eliminated from detailed consideration. Beyond the “No-Action” Alternative, other alternatives selected for detailed evaluation are those expected to alleviate the sediment deficit, optimize the performance and cost effectiveness of the Project, restore the recreational beach, provide marine turtle nesting habitat, provide storm protection for upland property and infrastructure, and minimize environmental impacts to the nearshore hardbottom resources.

Based on the information and analysis in the “Affected Environment” (Section 3.0) and the “Environmental Consequences” (Section 4.0) sections, the Project Alternatives discussion presents the beneficial and detrimental environmental impacts of the applicant’s Preferred Alternative and other alternatives in a comparative form. This section, in combination with others, is intended to provide a clear basis for choice among options available to the decision maker and the public. This section provides substantial detail for each alternative considered including the applicant’s Preferred Alternative so that reviewers may evaluate the comparative merits of all alternatives.

Consistent with guidance in 33 CFR 325, Appendix A, beyond the “No-Action” Alternative, other alternatives selected for detailed analysis are those that are feasible, accomplish the applicant’s underlying purpose and need, and that satisfy the preferred federal action alternative (permit issuance). In general, the detailed analysis of the alternatives identified below is intended to support both the public interest review and the 404(b)(1) guidelines reviews, where applicable.

The proposed action is the issuance by the USACE of the Section 404/Section 10 permit necessary for authorization and construction of the applicant’s Preferred Alternative, as set forth below.

2.1. Description of Alternatives Evaluated in Detail

In this section, the analysis will explore and objectively evaluate the “No-Action” Alternative and all reasonable alternatives to accomplish the Project purpose and need. The three Project alternatives considered in greatest detail are:

- Alternative 1 - "No-Action" Alternative
- Alternative 2 – Beach Fill with Structures
- Alternative 3 – Beach Fill with Periodic Nourishment (Preferred)

2.1.1 Alternative 1 - "No-Action" Alternative

The "No-Action" Alternative is one that results in no construction or actions requiring a USACE permit. The "No-Action" Alternative may occur by either: (1) the applicant electing to modify the Project to eliminate work under jurisdiction of the USACE; or (2) by denial of the permit.

The "No-Action" Alternative is evaluated in light of the current and expected conditions of the shoreline in the Project area. Two baseline assumptions as to the presence of nearshore hardbottom features were modeled in the analysis of the "No-Action" Alternative: Assumption 1 – the presence of sporadic nearshore hardbottom in the Project area based on aerial photography; and Assumption 2 – the assumed presence of uniform nearshore hardbottom throughout the Project area, even if not reflected in available aerial photographs. The "No-Action" Alternative analysis projects shoreline conditions in the absence of any fill placement, based on the analysis of shoreline change, volume losses, and sediment transport conditions as identified in Section 3.2. The analysis also includes the extent to which the "No-Action" Alternative (under either Assumption 1 or 2 baseline conditions) meets the Project purpose and need.

Model Assumption 1: The "No-Action" Alternative is used to analyze the predicted future condition of the shoreline without a beach fill project. Figure 2.1 includes the results of this evaluation which shows the projected shoreline from R-121 to R-123 after eight years. From R-116 to R-121 the shoreline is assumed to be hardened only to the extent aerial photographs reveal the presence of existing nearshore hardbottom or known seawalls. The aerial photographs from R-121 to R-123 do not reflect the consistent presence of nearshore hardbottom and therefore the model does not assume the presence of a uniformly hardened shoreline.

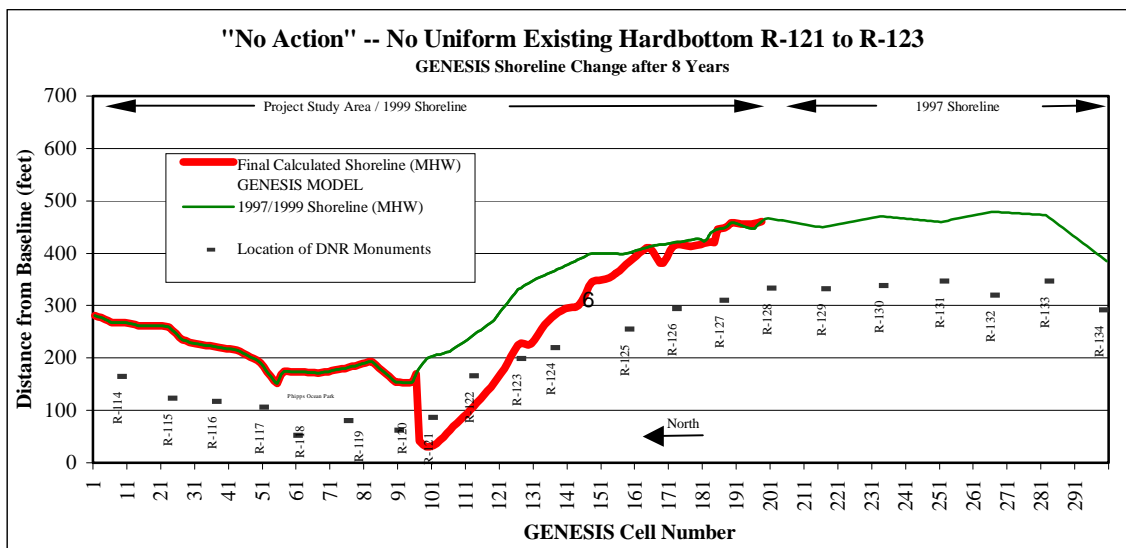


Figure 2.1 "No-Action" - No Uniform Existing Hardbottom R-121 to R-123

Under this assumption, the shoreline is clearly projected to erode further in the absence of beach nourishment. The model predicts substantial shoreline retreat of as much as 100 feet in some areas over the eight-year simulation. This demonstrates the expected southerly migration of the existing erosion problem into the shoreline between R-121 and R-126. Assuming the presence of sporadic nearshore hardbottom, the “No-Action” Alternative would be expected to result in the following conditions relevant to the Project purpose and need:

- Failure to mitigate the long-term erosion impacts of Lake Worth Inlet and the erosion impacts of the three-miles of armored coastline immediately north of the Project area.
- Failure to provide and maintain storm protection to upland improvements.
- Failure to restore and maintain the beach for public recreational use.
- Failure to restore and maintain the beach for marine turtle nesting habitat.

Model Assumption 2: In the second no-action simulation, the presence of a uniform nearshore hardbottom feature was assumed between R-121 to R-123, essentially treating the shoreline as effectively hardened in this reach (Figure 2.2). The alignment of the assumed hardbottom feature was based on the projected alignment of the visible existing nearshore hardbottom immediately north of R-121.

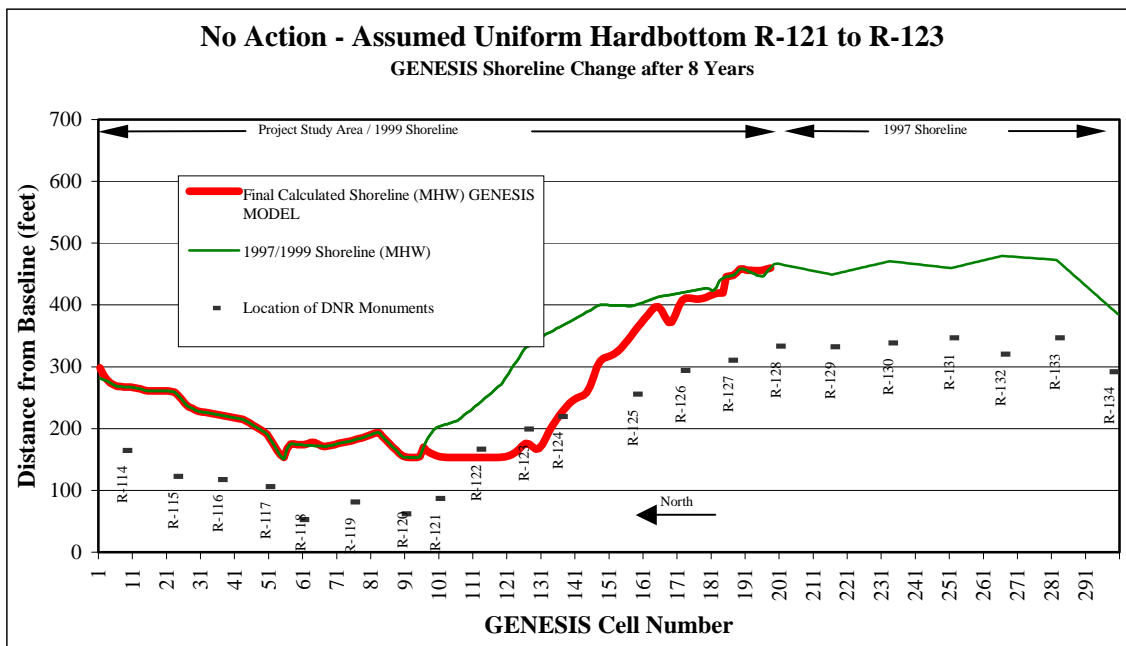


Figure 2.2 "No-Action" - Assumed Uniform Hardbottom R-121 to R-123

In the second simulation, the expected shoreline retreat is substantially less dramatic due to the assumed presence of a uniform hardbottom feature between R-121 and R-123. This “No-Action” Alternative would be expected to result in the following conditions relevant to the Project purpose and need:

- Failure to mitigate the long-term erosion impacts of Lake Worth Inlet and the erosion impacts of the armored coastline immediately north of the Project area.
- Failure to provide and maintain storm protection to upland improvements. The natural rock does not provide adequate storm protection to upland improvements (even though the natural rock may stabilize the shoreline).
- Failure to restore and maintain the beach for public recreational use.
- Failure to restore and maintain the beach for marine turtle nesting habitat.

If the “No-Action” Alternative is selected, there is no reasonable expectation that the Project purpose and need can be satisfied. Even if the entire Project area shoreline is assumed to be effectively hardened (by either artificial or natural features), the “No-Action” Alternative fails to mitigate for the adverse affect of Lake Worth Inlet and fails to provide a public recreational beach or restore sea turtle nesting habitat. In addition, continued efforts to armor the shoreline (consistent with established past practice) can be assumed, at a cost of several million dollars to the public and beachfront landowners. The expected loss of land as well as construction and maintenance of erosion control structures would be in excess of the cost of the Preferred Alternative, without realizing the benefits of beach restoration and maintenance. While the “No-Action” Alternative would avoid any adverse impact to nearshore hardbottom resources, this alternative fails to meet the Project purpose or need and is not viable.

2.1.2 Alternative 2 – Beach Fill with Structures

The second alternative response to shoreline erosion in the Project area is to implement a beach nourishment project in combination with installation of a groin field. In some cases, the cost of installing groins in combination with beach fill can be justified to reduce sediment losses and the frequency and cost of future renourishment. Under some conditions, groins can aid in retention of placed sand and reduce negative environmental consequences associated with renourishment of the Project area. By trapping and retaining sand, groins inherently reduce sediment transport to downdrift beaches and can increase erosion of downdrift beaches. In these cases, additional fill of the downdrift beaches may be recommended to prevent increased erosion to these beaches.

Several groin configurations are possible; however, the Beach Fill with Structures Alternative evaluated involves installation of six groins spaced at approximately 450-ft intervals, beginning 700 feet north of Phipps Ocean Park and ending 400 feet south of the Park. The placed fill volume would be 1.5 million cubic yards between R-116 and R-126. The estimated Project cost would be \$8.55 million for the fill material and \$1.64 million for the groins.

The GENESIS model was used to assess the expected performance of the Beach Fill with Structures configuration. For all simulations, permeable rock groins with a crest elevation of +5.0 feet NGVD and extending 150 feet seaward of the 1999 shoreline were assumed. The groins modeled assume retention of 90% of the sand they impounded.

The three northernmost groins are projected to retain minor pocket beaches on the order of 20 feet of additional dry beach eight years after the initial nourishment (Figure 2.3). The additional dry beach width would be limited to approximately 1,400 linear feet of shoreline within the northern three groins. The other groins remain largely buried by the beach fill and have no positive effect on fill performance. In all, the northern groins can be expected to retain approximately 10,000 cubic yards of sand after eight years, thereby slightly reducing future renourishment volumes.

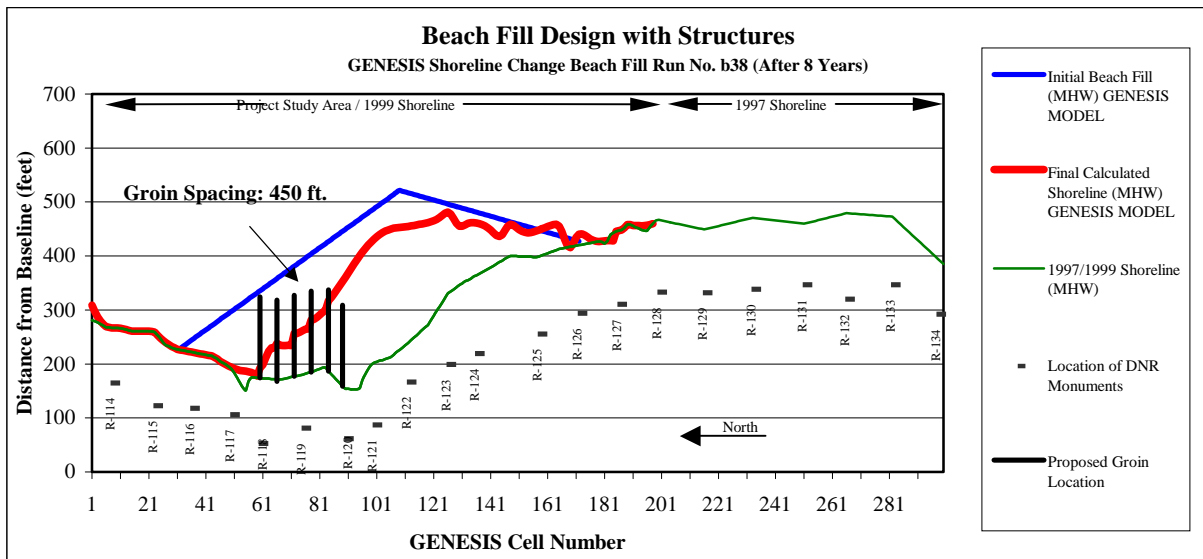


Figure 2.3 Beach Fill Design with Structures

With the cost of sand estimated for the initial Project at \$4.50 per cubic yard, and assuming a 3% annual inflation rate, installation of groins would reduce the renourishment cost in year eight by approximately \$57,000. Assuming similar cost savings beyond the first renourishment cycle, installation of groins at a cost of more than \$1 million is not cost-effective.

2.1.3 Alternative 3 - Beach Fill with Periodic Renourishment (Preferred)

Consistent with the analysis set forth in the Coast of Florida (COF) FEIS, Beach Fill with Periodic Renourishment is the Preferred Alternative. This alternative differs in minor respects to those considered in the COF study in purpose, length, and expected renourishment interval. Section 3.0 of the SEIS analyzes the potential impact of this Beach Fill with Periodic Renourishment Alternative on the regional sediment transport conditions. Section 4.0 examines the environmental consequences of this alternative with respect to potential storm damage reduction benefits, recreational beach access, marine turtle nesting areas, and other parameters.

The key features of the Beach Fill with Periodic Renourishment Alternative are:

- Placement area 1.9 miles long from R-116 to R-126.
- Placement volume of 1.5 million cubic yards of sand.
- Berm elevation design profile of +9 feet NGVD.
- Construction berm width varying from 140 to 330 feet.
- 3.1 acre artificial reef for hardbottom mitigation.
- Renourishment interval - eight years.
- Estimated Project cost of \$9.3 million.

To improve Project performance over the eight-year renourishment interval, the design volume includes approximately 500,000 cubic yards of advance fill. To account for the longshore transport from north to south, the fill volume is not placed uniformly over the Project length from R-116 to R-126. Instead, the optimal Project performance is achieved by placing a greater amount of the sand in the northern portion of the Project between R-116 and R-122. This design offsets expected excessive losses at the northern portion of the Project (R-116 to R-119), extends the Project life, and provides for acceptable Project performance.

The predicted performance of the Preferred Alternative was assessed using the GENESIS model. Model simulations were run to show fill performance at two-year intervals, from years two through eight. Figures 2.4 and 2.5 show the fill performance at years six and eight, respectively, following the initial placement.

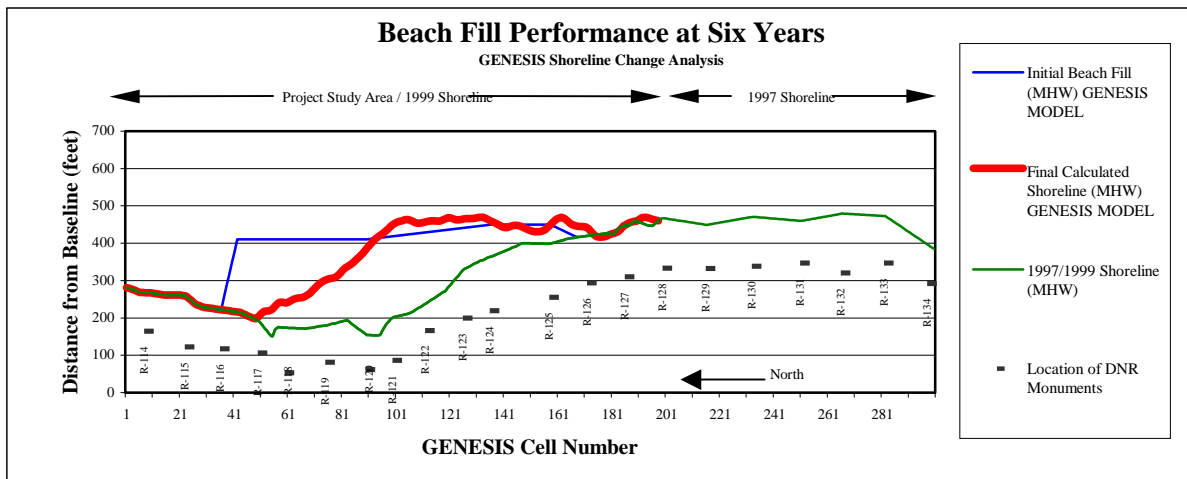


Figure 2. 4 Beach Fill Performance at Six Years

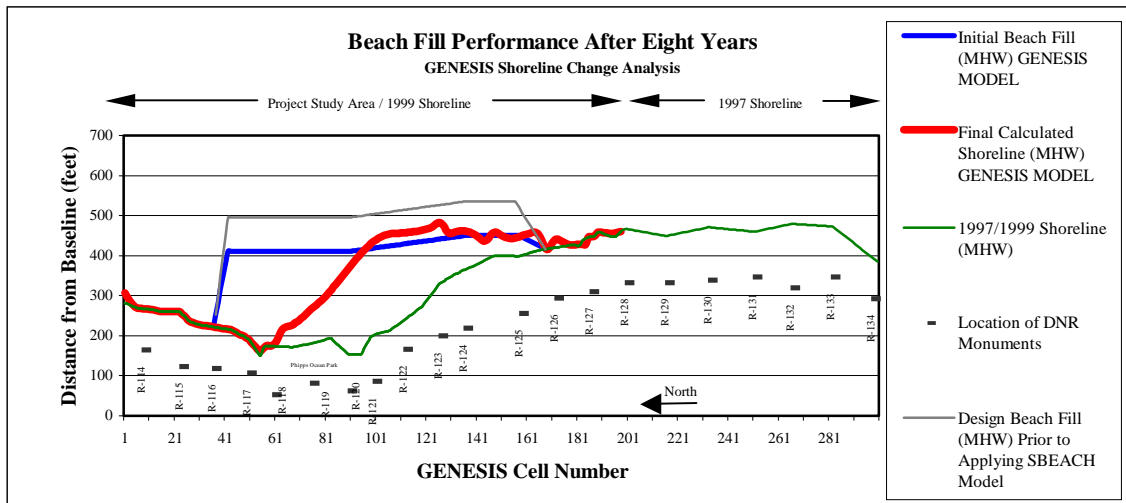


Figure 2.5 Beach Fill Performance After Eight Years

The Beach Fill with Renourishment Alternative satisfies the Project purpose and need. Six years after the initial placement, the shoreline is expected to erode back to the pre-fill condition between R-116 and R-117, but not further due to the presence of the existing rock revetment and nearshore rock features on the shoreline. Eight years after the initial fill, the shoreline is expected to erode back to the pre-fill condition between R-116 and R-118 (Figure 2.5). The remainder of the Project area shoreline would also suffer erosion losses, but not to the extent of the pre-fill shoreline conditions.

As discussed in Section 4.0, restoration of the beach in the Project area will unavoidably impact a total of 3.1 acres of nearshore hardbottom resources immediately adjacent to the shoreline. Even if the fill placement area and volume are reduced by half, the extent of impact to nearshore hardbottom resources would not be substantially less due to spreading of the fill along the Project area shoreline (Section 2.3.2, Reduced Fill Area Design). To mitigate the unavoidable impact to hardbottom resources, the Preferred Alternative includes construction of a 3.1-acre mitigation reef six months in advance of the fill placement, as described in Appendix E, Mitigation Reef Plan and Monitoring Program.

The Beach Fill with Renourishment Alternative fully meets the Project goals and objectives between Monuments R-116 to R-126 and, through construction of the mitigation reef, potential adverse environmental consequences of the Project are minimized and compensated. As analyzed in Section 2.3, other fill placement alternatives, such as extending the fill placement area north by 2,000 feet or reducing the fill placement area by half, do not significantly improve Project performance or reduce potential impacts to nearshore hardbottom resources.

2.1.4 Sand Source Alternatives Analysis

In concert with planning by the Town of Palm Beach, alternative sand sources were investigated. These alternative sources include offshore borrow areas, and other deep water, upland, and foreign sand sources. Other potential sources of fill material were also examined and are described below.

2.1.4.1 Offshore Borrow Areas (preferred)

The Town of Palm Beach conducted extensive investigations of the offshore region from Lake Worth Inlet south 12.5 miles to the Town of South Palm Beach (CPE, 2000). Investigations were conducted within two (2) nautical miles of the shoreline and included bathymetric surveys, seismic surveys, side scan surveys, jet probes, vibracores, and cultural resource investigations. As identified in Figure 2.6, seven (7) potential offshore borrow areas have been delineated from these investigations. Every potential borrow area consists of a mixture of relict and modern marine sand, deposited during the Holocene marine transgression. The sand deposits are all located on a shallow terrace or shelf in 30 to 50 feet of water. Borrow area sands have accumulated upon the terrace in a depression created by the presence of two inner shelf limestone outcrops. The terrace narrows towards the south, causing the offshore margin of the basin to converge upon the shoreline.

Two bedrock features rim the depositional basin and are composed of biogenic Pleistocene (Anastasia Formation) limestone and provide an ideal substrate for marine benthic communities. In the nearshore, extensive hardbottom habitat has formed upon the limestone, while modern coral reef communities have colonized the offshore bedrock outcrops. The offshore rim has been partially investigated and been found to be biologically productive (CSA, 2000a). These two rim features provide a source of coarse sand and gravel-sized sediment that has been identified in all of the potential offshore borrow areas. Analysis of vibracore logs suggests the abundance of limestone clasts (a.k.a. intraclasts), coral fragments, or coarse shell debris is a function of proximity to hardbottom. The offshore reef along the seaward rim is probably a more significant sediment source because it lies along the seaward margin of the basin and is subject to a stronger wave climate induced by seasonal storm activity.

Construction by hopper dredge was specifically eliminated from consideration to avoid potential impacts to biological communities in the offshore reef along the seaward rim. Construction by hydraulic dredge is proposed; such construction is only economically feasible from borrow areas III and IV – the preferred sand source. Appendix G, Vessel Operations Plan, describes the conditions and restrictions governing the dredging of the preferred borrow areas as contained in the Joint Coastal Permit issued by FDEP for the Project. The plan includes a 400-ft no dredge buffer and a 200-ft no anchor buffer to avoid and minimize impacts to hardbottom resources in the vicinity of the borrow areas.

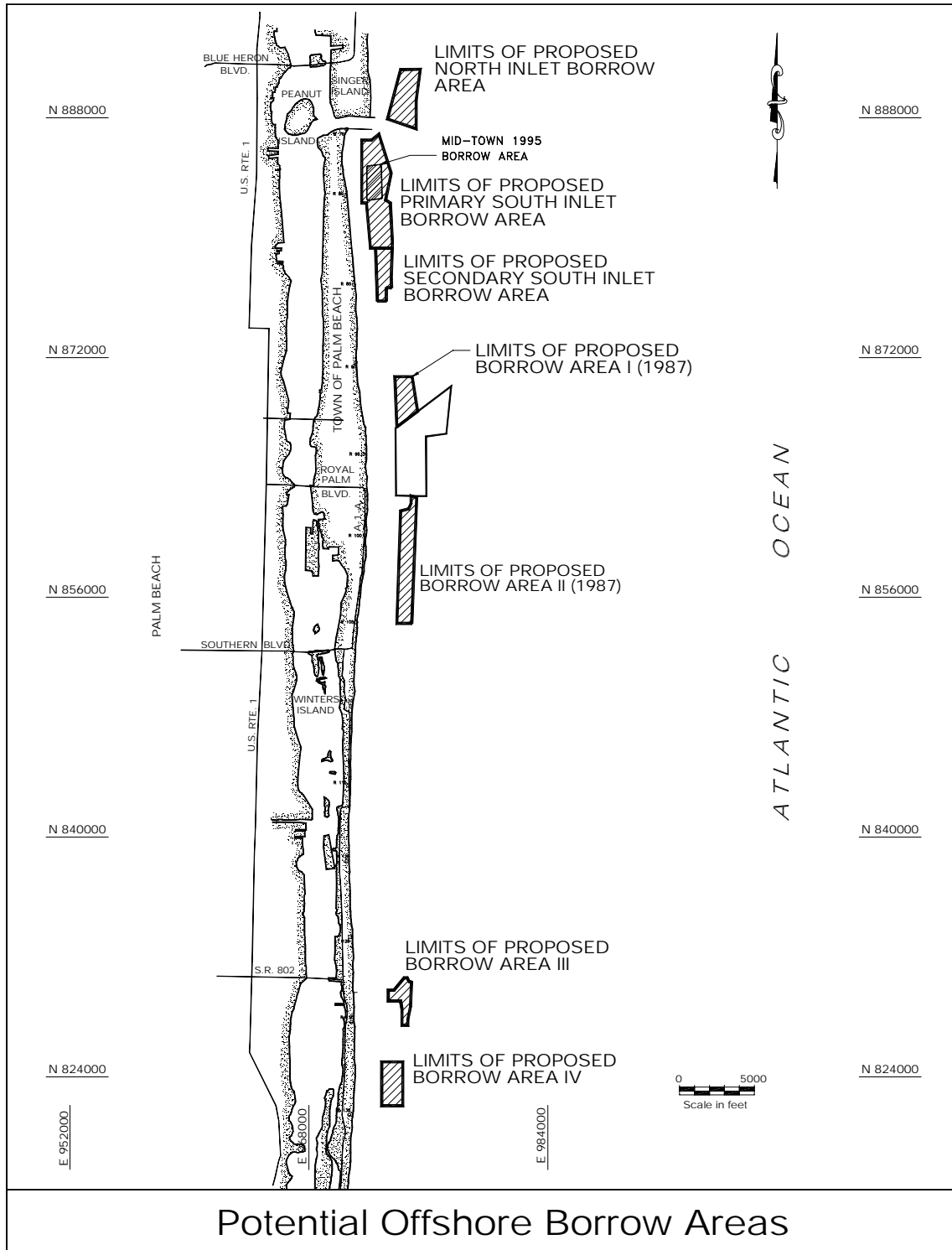


Figure 2. 6 Seven Potential Offshore Borrow Areas

Sand from the preferred sand source is best described as a gray, well-sorted mixture of quartz and arbonate sand, with trace silt content. The composite mean grain size ranges between 0.32 mm and 0.22 mm for Borrow Areas III and IV respectively. Silt content, also derived from composite sample analysis, ranges between 1.5% and 2.9%. Coarse sand and gravel content is generally less than 7%. Vibracore logs (CPE, 2000) indicate the presence of this coarse gravel and cobble in direct proportion to the proximity to hardbottom. A *Supplemental Geotechnical Analysis* (Coastal Tech, 2000d) determined the content of coarse gravel and cobble between 0.3% and 0.2% for Borrow Areas III and IV respectively.

Fill material derived from an offshore borrow area may cause some temporary water quality and hardbottom habitat degradation due to turbidity caused by the presence of fines. In general, the State of Florida has accepted that fill material with a percent of fines at 5% or less will not have a significant impact upon ambient water quality. Sand fill obtained from the preferred sand source contains less than 3% fines and is not expected to significantly affect water quality.

The sedimentology of the proposed offshore borrow areas is relatively uniform. Significant changes in compatibility, water quality, or habitat degradation are not expected through the selection of a specific area or cut.

The preferred sand source includes two sites (Borrow Areas III and IV) approximately 3,500 feet offshore and located between 1.5 and 2.6 miles south of the fill area (Figures 2.7 and 2.8). The preferred sand source is compatible with the native beach sand; this is addressed in greater detail in Section 3.3 of this SEIS.

2.1.4.2 Deep Water Sand Sources

The vast majority of offshore borrow areas are sited in relatively shallow water depths less than 100 feet. These shallow water sand sources are economically extracted using widely available technologies. Recovering sand from borrow areas located in water depths in excess of 100 feet requires the utilization of specialized equipment not readily available and can significantly increase Project costs.

Deep-water sand sources are not expected to be routinely targeted for dredging until the inventory of shallow water borrow areas has been exhausted. During this review, no projects were identified from which information on the location, quantity, suitability, cost, or environmental impacts of deep water sand sources could be extracted. This type of information will become available with the decline in shallow water reserves. However, it is unlikely that deep-water sand source information will be available for consideration during the planning and construction of the proposed Project.

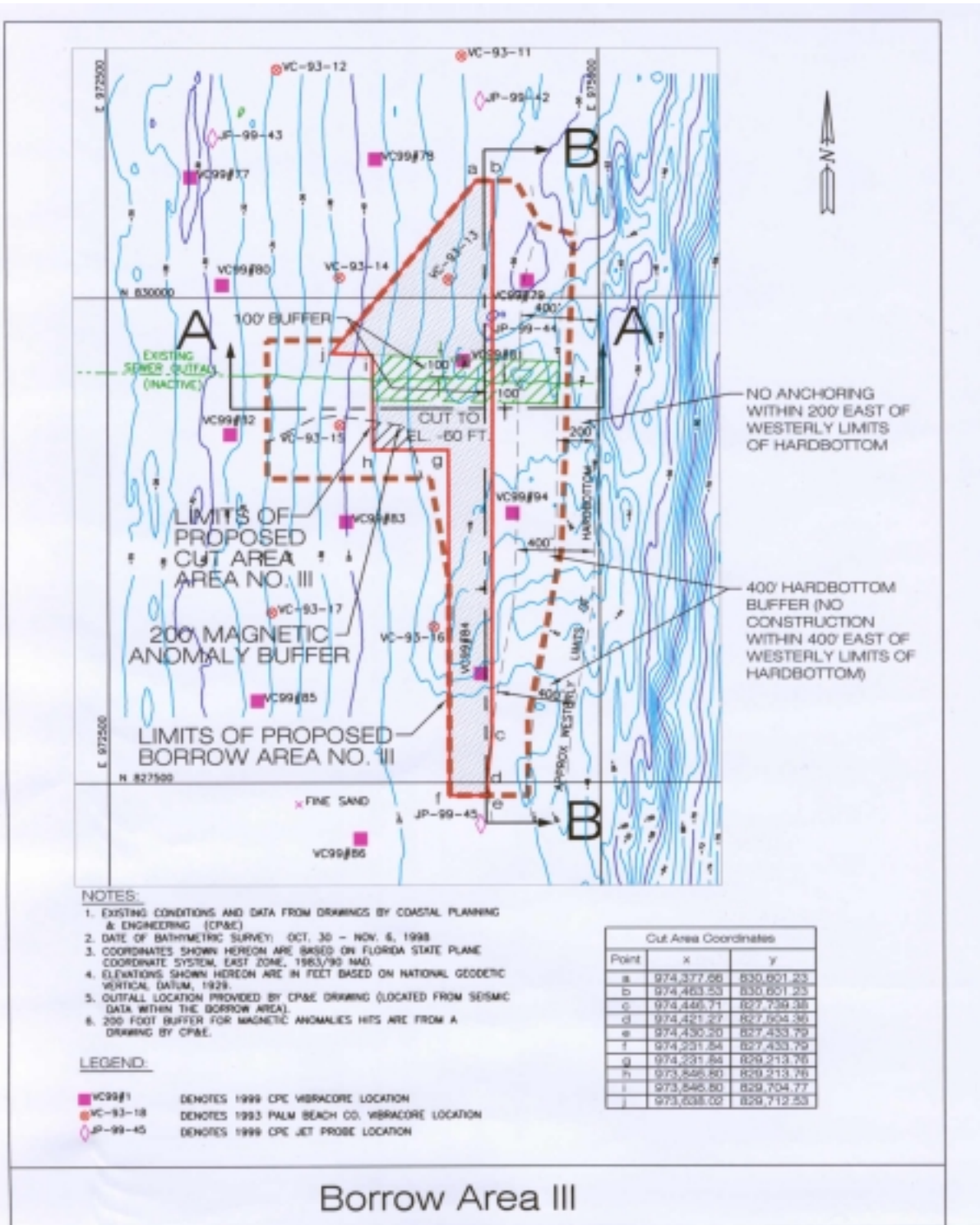


Figure 2.7 Borrow Area III

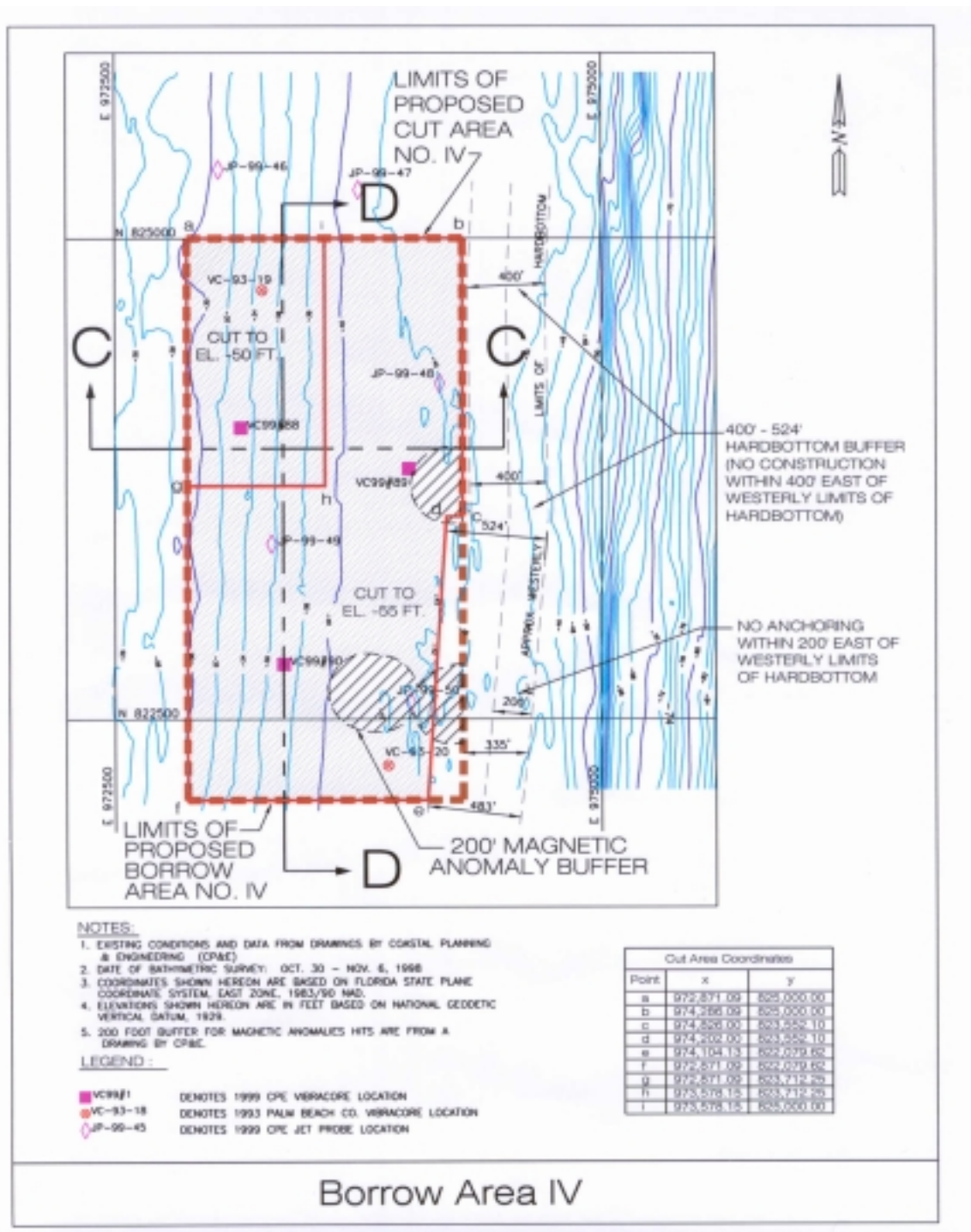


Figure 2. 8 Borrow Area IV

2.1.4.3 Upland Sand Sources

Upland sand source areas are generally confined to sand pits or mines currently producing material that may be compatible with native beaches. The largest reserves are located in the Central Highlands physiographic region of peninsular Florida and include the Lake Wales Ridge. Additional sand deposits are associated with other relatively high relief (+50 ft) relict coastal features in the Coastal Lowlands physiographic region. These include the Ten Mile Ridge and Atlantic Coastal Ridge. Numerous small mining operations also extract Cenozoic marine sands from the low-relief areas within this physiographic region.

The material from upland sand mines consists of medium to fine grained quartz sand with trace (<5 wt%) fine and organic content. Mean-grain size can be expected to range between 0.50 millimeter and 0.30 millimeter. Subjected to extensive chemical weathering, upland sand deposits are composed of nearly pure quartz, with carbonate or shell content typically less than a few percent.

These data indicate upland sands are texturally compatible to the native beaches of southeast Florida. However, the shell content of south Florida beaches is generally in excess of 25% and at some localities the beach sand consists entirely of shell material. The upland sand sources are therefore not generally compatible to south Florida beaches with regard to mineralogy or composition. The impact of these distinctions is perhaps most significant to the ecological function of a beach. Altering the mineralogy might potentially affect marine turtle nesting density and hatching success by changing the temperature, moisture content and/or hardness of a nesting beach.

Additional ecological impacts may occur at the site of upland sand source recovery, especially if it is located upon one of the peninsula's sand ridges. Florida's sand ridges are relict marine terrace or shoreline features that formed in association with one of many sea-level highstands. Today, the Lake Wales Ridge, Ten Mile Ridge, and Atlantic Coastal Ridge generally host Florida scrub or flatwood plant communities. These communities often support threatened and endangered species that may be impacted by the development or expansion of an upland mine.

In addition to potential ecological effects, utilization of an upland sand source may also impact an area's infrastructure during transportation from the mine to the Project location. Historically, overland transportation of beach fill has been achieved using dump trucks. Significant adverse impacts associated with this type of transportation can be expected, including degradation of the structural integrity of roads and buildings, reduction in traffic safety and air quality, and increased noise pollution. Establishing trucking weight limits can mitigate potential damage to infrastructure; however, the number of truckloads required to place the fill volume would increase substantially. For example, at a reduced load of 10 cubic yards per haul, the proposed 1.5 million cubic yard nourishment Project will require approximately 150,000 truck loads of sand be driven through the Town of Palm Beach. To

reduce potential construction delays and control costs, trucking on this scale would most likely be continuous, causing substantial disruption of local traffic patterns and great inconvenience to the general public.

The broad spectrum of adverse impacts created by the use of an upland sand source is not justified by the minor benefits generated from the selection of this alternative. The "Comprehensive Coastal Management Plan Update, Palm Beach Island, Florida" (ATM, 1998), similarly concluded that, "The unit costs and impact to infrastructure (roads) associated with truck hauling to the Project area make this alternative not viable ..." for the quantities needed to restore the beach within the Project area.

2.1.4.4 Foreign Sand Sources

Potential sand sources have been identified throughout the wider Caribbean region, including coastal and offshore deposits located in the Bahamas and Turks & Caicos. The sand consists of biogenic carbonate (i.e. shells) and physiochemical precipitates (i.e. oolite) generally located in subtidal, high-energy areas. The depositional environment produces smooth, well-worn sand grains with a mean grain size between 0.25 millimeter and 0.75 millimeter. The wave-dominated environment generally precludes the accumulation of fines, so deposits contain only trace amounts of silt and clay.

The textural features of Caribbean marine sands are compatible with the native beaches of southeast Florida and the content of fines would cause minimal turbidity during construction. However, there remain questions and uncertainties regarding the potential formation of beach rock and alterations to the physical environment of marine turtle nesting beaches. Oolitic sands are composed of aragonite, a common marine mineral that is soluble in seawater. Under arid climatic conditions, aragonite sands will rapidly (months to years) lithify to form beach rock at or very near (i.e. inches to feet) the surface. In addition, the mono-mineralic foreign sand has a distinct heat capacity that may alter the *in situ* temperature of a marine turtle nesting beach.

Additional considerations regarding the logic in using foreign sand deposits to nourish Florida's unstable beaches includes the distinct shape and specific gravity of aragonite sand, either of which may change hydraulic behavior of this sediment. Finally, the potential presence of exotic organisms on foreign sand cannot be overlooked.

The USACE, in consultation with the U.S. Fish & Wildlife Service (USFWS), FDEP, and Miami-Dade County Department of Environmental Resources Management (DERM) have begun tests to determine the potential impacts of foreign carbonate sand on the physical and biological conditions of a native beach. A pilot project was completed at Fisher Island; however, the large-scale and repeated use of Caribbean sands is not considered appropriate at this time.

2.1.4.5 Inlet By-Pass Sand Sources

The Lake Worth Inlet shoal complex includes both flood and ebb sand deposits. The sediment in these formations has been examined as a potential sand source because it is derived directly from the native beach via the interaction of longshore current and tidal flow. Flood shoal sediments generally accumulate in sensitive marine habitat or navigable waterways, complicating their use as a sand source for beach nourishment. In addition, the volume of available material is generally less than 0.5 million cubic yards.

The ebb shoal complex has been previously investigated and subdivided into a northern and southern area. The complex consists of sand with a mean grain size of approximately 0.25 millimeter to 0.30 millimeter, with trace silt content. Coarse sand, shell, and coral fragments were identified in both areas. Submarine cementation was encountered at distinct elevations in both the northern and the southern areas as well.

The Lake Worth flood shoal is not considered as a realistic option because it is small and located within sensitive marine habitat. The ebb shoal complex does not appear to be a viable alternative either. The presence of coarse sand, shell, and coral fragments are aesthetically undesirable and may potentially be problematic to nesting marine turtles. In addition, beach rock has also been documented in both the northern and southern areas, although the south shoal area was used as fill in conjunction with the Mid-Town Project.

Another related but undermined potential sand source at Peanut Island has been identified by the USACE, Jacksonville District and is described in the “Draft Environmental Assessment, Change in Maintenance Operations at Palm Beach Harbor and Peanut Island, Palm Beach County, Florida” (September 2000). According to the EA, Peanut Island is a 79-acre island formed through the placement of dredged material over the last 80 years during the creation and maintenance of the Intracoastal Waterway (IWW), Lake Worth Inlet and Palm Beach Harbor. Under the proposed plan, the dredge disposal site on the southern end of Peanut Island would be offloaded of the material stockpiled there and placed into one of three new disposal areas: (1) near-shore disposal area south of Lake Worth Inlet south jetty, (2) Mid-Town Beach, or (3) the “anoxic hole” adjacent to the City of Lake Worth Municipal Golf Course. The third alternative is the least cost option and, while no final disposal option has been selected, appears to be the most viable.

The dredged material placement option closest to Peanut Island is the beach south of Lake Worth Inlet. Using a conventional dredge pipeline, the District has determined that this beach area could accommodate 600,000 cubic yards of dredged material from the Peanut Island disposal site. The Mid-Town Beach site could also accommodate 600,000 cubic yards of material, beginning south of the Breakers Hotel and continuing south for approximately 2.25 miles.

The District did not evaluate potential placement of the Peanut Island material on Phipps Ocean Park Beach or determine the potential hardbottom impacts of placement south of Lake Worth Inlet or on the Mid-Town Beach. However, placement of an additional 600,000 cubic

yards of sand south of Lake Worth Inlet is unlikely to impact the rate of erosion or shoreline change conditions in Phipps Ocean Park over the long-term.

2.2 Issues and Basis for Choice

2.2.1 Project Alternatives

The alternatives were evaluated based on analyses of accomplishment of the Project purpose and need, historic shoreline trends, numerical modeling, and effects on the environment. Specific factors used as a basis for choice of the Preferred Alternative include hardbottom and reef impacts, sea turtle nesting and foraging habitat, public recreation, sediment budget restoration, and public safety (see Section 1.8.2). The Preferred Alternative is technically and economically feasible and best achieves the Project purpose with the least detrimental environmental consequences.

2.2.2 Sand Source Alternatives

The alternative sand sources were evaluated based on an analysis of the quantity and quality of available sand, economic and technical feasibility of the source, and the potential environmental consequences of utilizing the sand source.

2.3 Alternatives Eliminated From Detailed Evaluation

This section describes other alternatives within the jurisdiction of the lead agency that may partially achieve the purpose and need of the Project, but that were eliminated from detailed consideration. In general, alternatives were eliminated from detailed discussion if they were either not technically or economically feasible or if they failed to adequately achieve the Project purpose or need. In addition, this section describes alternatives evaluated and eliminated during the FDEP permitting process such as installation of a Prefabricated Erosion Prevention (PEP) reef, installation of groins (without beach fill), and modification of the Lake Worth Inlet sand transfer plant. Finally, this section advances the alternatives described and considered in the COF FEIS (October 1996).

2.3.1 Alternative 4 - Increased Fill Area Design (Placement of additional 343,200 cubic yards between R-114 to R-116):

The Increased Fill Area Design Alternative would extend the fill area 2,000 feet further north of the preferred Project alternative to include the area between R-116 to R-114. Fill placed in the area north of the preferred Project area would potentially serve as a feeder beach and could be expected to improve the Project performance or extend the Project life.

If the Project is expanded 2,000 feet north to R-114, the total Project length would increase from 1.9 to 2.33 miles and the total fill volume would increase from approximately 1.55 million to 1.89 million cubic yards, or 343,200 cubic yards (Table 2.1). Consistent with the Preferred Alternative, between Monuments R-114 and R-116, the average sand placement rate would be 172 cy/ft. Applying the same design principles as the Preferred Alternative, fill performance is expected to require renourishment every eight years. Thus, the remaining sand quantity prior to each maintenance event is approximately equal to the 15-year design storm event, the minimum buffer necessary to protect upland areas.

Table 2.1 Alternative 4 - Increased Fill Design Characteristics

Reference Monument	Fill Density		Distance (ft)	Volume (cy)
	@ Mon. (cy/ft)	Mean (cy/ft)		
R-114	4	70	1,000	70,160
R-115	136	154	1,000	153,950
R-116	172	172	1,040	178,880
R-117	172	172	730	125,560
R-118	172	190	1,179	223,892
R-119	208	236	1,106	261,514
R-120	265	254	722	183,532
R-121	244	227	945	214,799
R-122	211	180	1,022	183,449
R-123	148	125	985	123,371
R-124	102	90	1,490	134,026
R-125	78	39	1,088	42,214
R-126	0			
		Totals:	12,307 ft	1,895,347 cy
Total Preferred Fill Volume				1,552,147
Total Increased Fill Volume				343,200

Higher sand placement quantities in the beach fill template associated with this alternative would be expected to result in greater coverage of nearshore hardbottom and possible sedimentation of sea turtle feeding areas and interstitial spaces in the nearshore reef structure (Figure 2.9). In addition, this alternative would be expected to require a longer construction window to accomplish the initial restoration. Cumulative impacts to sea turtle nesting in the seasons following Project construction would be reduced due to a longer renourishment interval.

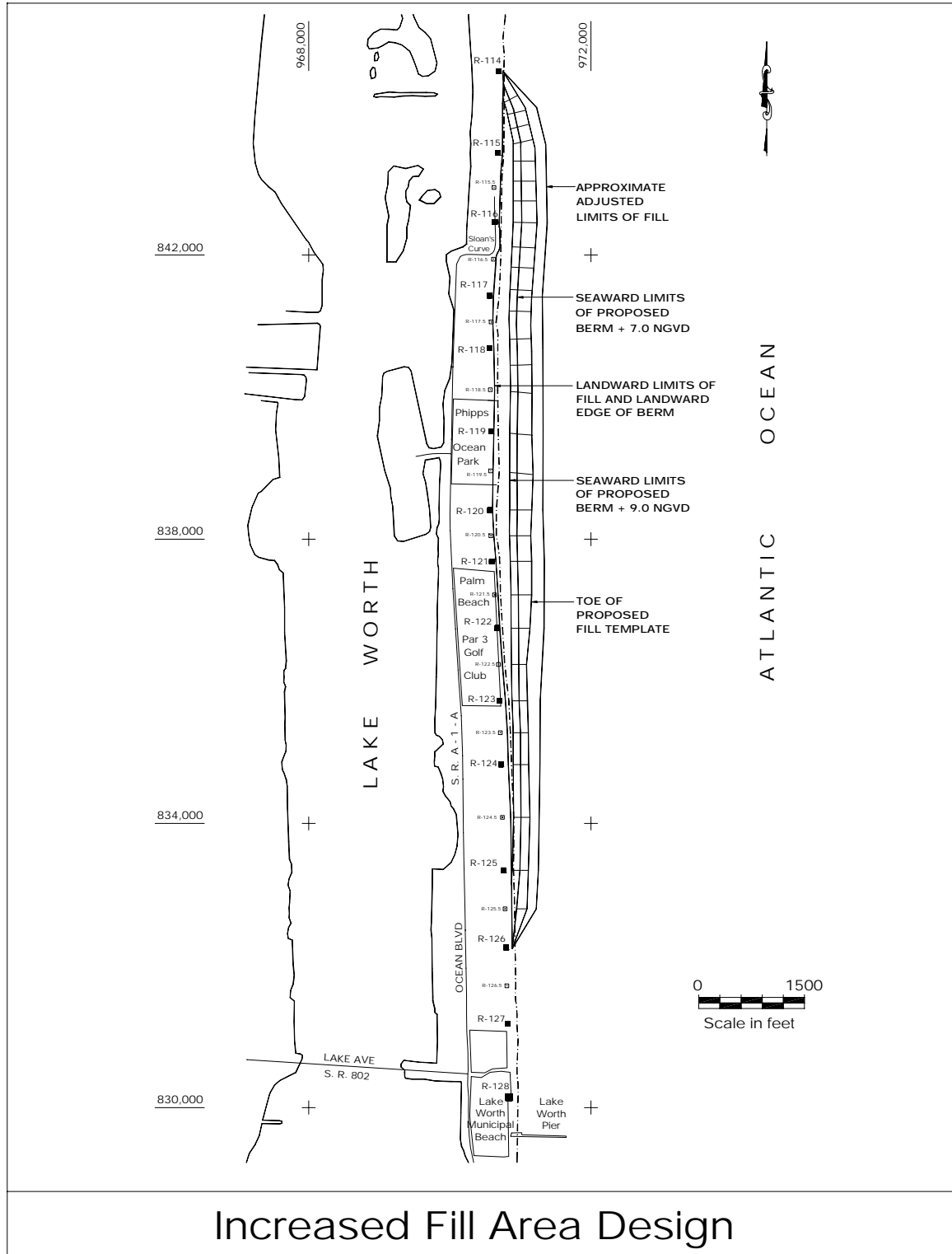


Figure 2. 9 Increased Fill Area Design

The total estimated construction cost for the Increased Fill Alternative is \$12 million. This alternative is expected to adversely impact an additional 2.9 acres of high quality nearshore reef in water depths ranging from -9.6 feet to -14 feet. General hardbottom types located in the nearshore Project area are described in detail in Section 3.7. Based on aerial photography, it is apparent that extensive nearshore reef exists from R-114 to R-116; therefore, Alternative 4 was eliminated from consideration as a viable Project alternative.

2.3.2 Alternative 5 - Reduced Fill Area Design (Placement of 0.75 - 1.5 million cubic yards between R-116 to R-121)

Ideally, the Reduced Fill Area Design Alternative would be one that avoids entirely the direct burial of any nearshore hardbottom resources. This is not possible, due to the extensive nearshore hardbottom features that currently exist throughout the Project area; however, this alternative reduces the fill placement area by 50% and the initial fill placement volume by up to 50%.

The evaluation of the Reduced Fill Area Alternative assumed three initial fill placement volumes (0.75 million, 1.13 million and 1.5 million cubic yards) all placed between Monuments R-116 and R-121 (Figure 2.10). These scenarios all reduce the preferred Project length from approximately 10,000 to 5,000 feet. Depending on the volume placed, the design fill template would extend from 300 to 550 feet seaward of the line of mean high water. In comparison, the approximate mean high water line of the Preferred Alternative fill template extends seaward between approximately 190 to 380 feet.

For all three fill placement volumes, the GENESIS model runs showed that the fill would spread rapidly from this limited initial placement area and be distributed along the shoreline from Monuments R-121 to R-124. Nearshore hardbottom resources between R-116 and R-121 would be directly impacted and buried by the initial fill placement for all fill volumes. In addition, nearshore hardbottom resources between R-121 to R-124 would also be impacted over time as the placed fill would mitigate and spread to the south.

For the three potential fill volumes, the average placed sediment volume for the initial nourishment of Alternative 5 varies from 150 to 300 cy/ft over the total Project length of 5,000 feet. The mean dry beach width varies from approximately 200 to 430 feet following initial adjustment. Compared to the Preferred Alternative, the renourishment frequency for the Reduced Fill Area Alternatives is equal or greater (depending on the initial fill volume).

The Reduced Fill Area Design Alternative fails to significantly reduce the hardbottom resources impacted and would result in additional environmental impacts associated with more frequent renourishment intervals. With each dredging operation, sediment in the borrow area is suspended, increasing the turbidity of the water within and surrounding the borrow area. This increased turbidity decreases the water quality of that area and might impact habitat.

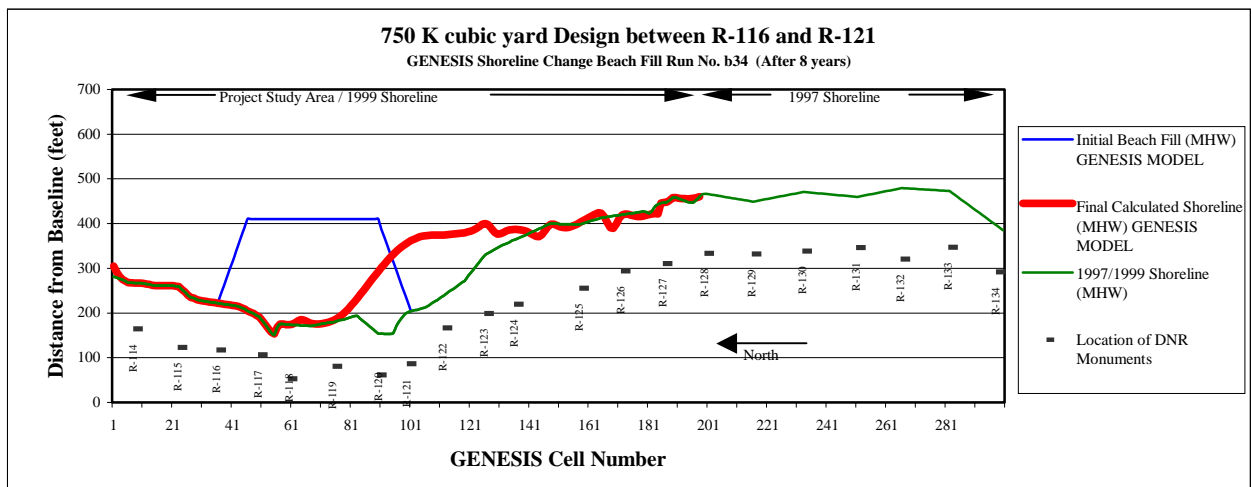
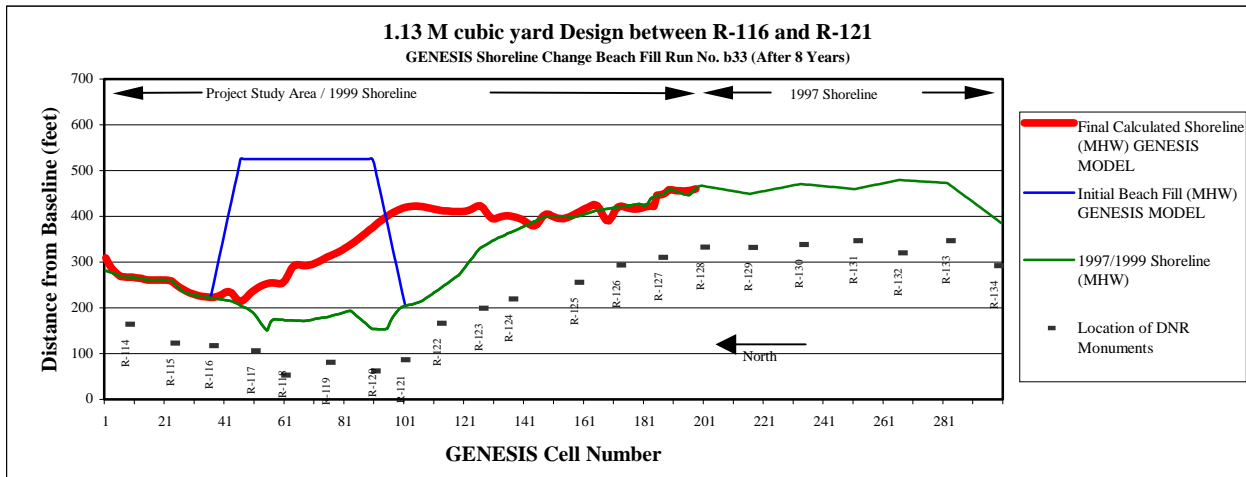
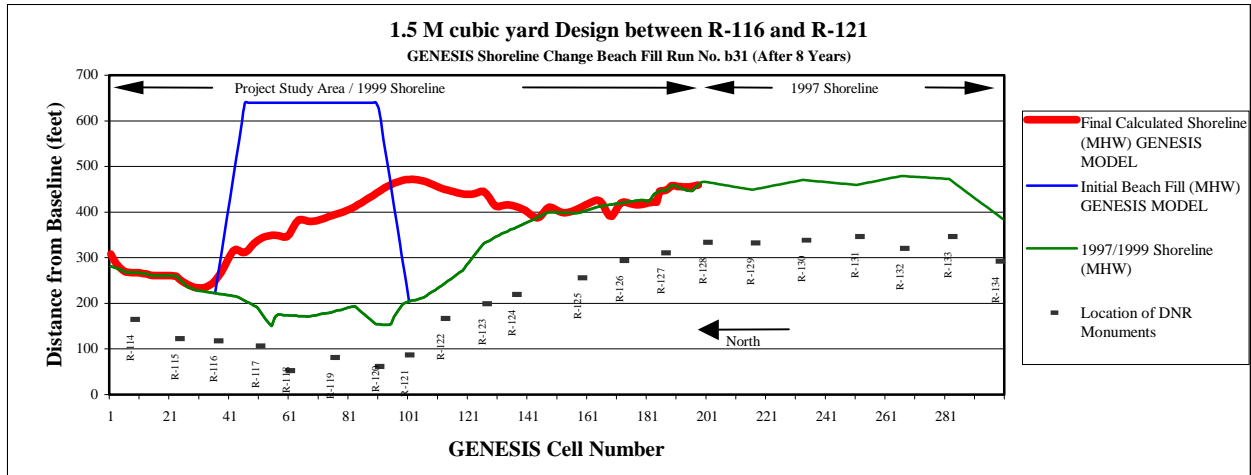


Figure 2. 10 Reduced Fill Area Design

Placement of sediment onto the beaches also increases turbidity within the nearshore mixing zone and might temporarily diminish habitat quality. A shorter renourishment interval could increase the overall impacts to sea turtle nesting habitat within the renourishment area. The greatest impact to turtle nesting occurs in the first nesting season following construction of a Project. Alternative 5 is not viable or recommended.

2.3.3 Alternative 6 - Revetment

Revetments have been placed on beaches in the past to protect critically damaged or eroding areas, including in the area immediately north of the Project area. These measures typically prevent erosion landward of the revetment but usually result in a steepening of the beach profile as sediment is carried off the beach. A revetment typically transfers erosion to beaches downdrift. The revetment north of Sloan's Curve has affected the Project area in this manner. Construction of a revetment would not serve the Project purpose and need with respect to maintenance of a recreational beach or restoration of sea turtle nesting habitat. Consequently, this alternative was eliminated from detailed evaluation.

2.3.4 Alternative 7 - Seawalls

The construction of additional seawalls or improvements to and maintenance of the existing bulkheads/seawall would provide a significant degree of upland storm protection; however, this would be accomplished at the expense of maintaining a recreational beach, resulting in substantial economic loss to the area. Reflecting wave energy off the existing seawalls and bulkheads has resulted in a steepening of the offshore profiles with resulting hazardous bathing conditions due to increased undertow and runouts. A seawall would not serve the Project purpose and need and was therefore eliminated from detailed evaluation.

2.3.5 Alternative 8 - Nearshore Berm

In some areas, construction of a nearshore berm can help restore an eroding beach and provide a measure of storm protection to upland property. This alternative entails placing material offshore of the beach to create and mimic natural sandbar features under certain conditions. Material is typically dredged from an adjacent inlet or offshore borrow area. Recent improvements in dredging technology allow construction of nearshore berms in water depths of ≤ 15 . This alternative was eliminated from detailed evaluation because it fails to satisfy the Project purpose and need, provides minimal storm protection for upland properties, and does not restore the recreational beach or create sea turtle nesting habitat.

2.3.6 Alternative 9 - PEP Reef

In the last ten years, several offshore breakwater projects, called PEP reefs, were installed in an effort to reduce beach erosion in Florida, including in Palm Beach County. In May 1988, approximately 552 feet of PEP reef was installed between DEP Monuments R-114 and R-116, at the DuPont Property north of the proposed Project area in the Town of Palm Beach. These structures have proven ineffective in reducing shoreline erosion and, based on more than two years of monitoring data, the state ordered the PEP reef removed. In December 1991, the Town of Palm Beach was authorized to construct an additional 4,000 feet of experimental PEP reef in the Mid-Town Beach area. In August 1992, 57 structural units some 684 feet in length were installed along the approximate 9-ft depth contour. The remainder of the reef was installed by August 1993. Based on three-year monitoring data, the submerged breakwater was found to exacerbate erosion. The Town of Palm Beach elected to voluntarily remove the PEP reef and use the materials for groin construction. Because the experimental PEP reefs installed in the vicinity of the Project area failed to prevent shoreline erosion or restore the recreational beach and sea turtle nesting habitat, this alternative was eliminated from detailed evaluation.

2.3.7 Alternative 10 - Groin Field Without Beach Nourishment

Under some conditions, groins and other sand trapping structures installed in the absence of beach nourishment can trap longshore sediment transport resulting in the restoration of a beach. These structures have the added advantage of creating or mimicking the biological productivity of nearshore hardbottom resources. Typically, installation of a multiple-groin system (a groin field) provides a more favorable shoreline response than a single-groin alternative, since the shoreline exhibits a more uniform response, and the design dimensions are maintained over a greater length of the project. As described in Section 3.2, a substantial annual sediment deficit exists in the Project area in excess of 100,000 cy/yr. Under these conditions, installation of a groin field without beach nourishment would not be expected to result in restoration of the recreational beach or creation of sea turtle nesting habitat. In addition, the Preferred Alternative is more likely to maintain the design cross-section over the entire Project length during the eight-year renourishment interval. Therefore, the installation of groins in the absence of beach fill was eliminated from detailed evaluation.

2.3.8 Alternative 11 - Modification of the Lake Worth Inlet Sand Transfer Plant

Lake Worth Inlet, located approximately 8.5 miles north of the Project area, completely interrupts longshore sediment transport from north to south, starving downdrift beaches of sand and causing shoreline erosion. To mitigate the downdrift impacts of the Inlet, Palm Beach County and the Town of Palm Beach in 1996 completed repairs to the Sand Transfer

Plant (STP) located adjacent to the north jetty at the extreme south end of Singer Island. Sand pumping operations resumed in May 1996. As a result, the Reach 1 (from Lake Worth Inlet South Jetty to Onondaga Avenue) shoreline experienced a build up of sand for the period of September/October 1990 to April/May 1997. With the continued STP discharging of sand onto the north end of Palm Beach Island and placement of beach-quality sand in the disposal area by the USACE, two principal objectives of sand bypassing across the Inlet and maintenance of the navigation channel are at least partially satisfied. However, additional actions are necessary to appropriately manage Lake Worth Inlet and its adverse impacts to the Palm Beach Island shoreline. Recommended actions include:

- Extension and modifications to current USACE dredge spoil disposal practices.
- Place future maintenance dredged sand further downdrift (south) of the Inlet by extending the STP pipeline discharge point.
- Monitor the Inlet littoral processes, STP operations, and validate the Lake Worth Inlet sediment budget.
- Complete improvements to the STP capacity to enable it to achieve annual bypassing goals.

If these actions were implemented, one of the specific purposes of the proposed Project (correction of the ongoing sediment transport deficit created by the Inlet) would be achieved. However, this alternative does not address historical Inlet impacts and does not achieve the other Project purposes because several additional barriers to longshore sediment transport into the Project area exist over the 8.5 miles from Lake Worth Inlet to the north boundary of the proposed Project. No reasonable expectation exists that further modification of the Lake Worth Inlet STP would restore the recreational beach at Phipps Ocean Park, create sea turtle nesting habitat in the Project area, or reduce the potential storm damage in the area. This alternative was therefore eliminated from further detailed evaluation relative to this Project.

2.3.9 Alternative 12 - Dune Restoration

Under certain conditions, dune restoration can over time serve as an essential component for shoreline stabilization and restoration efforts. Typically, this alternative would include reconstruction of a sand dune or berm along the proposed Project length, installation of sand fences, and revegetation of the dune or berm with native plant species. The sand fences and vegetation serve to stabilize and maintain the dune. A dune restoration project would provide some storm protection, but would not in itself restore the recreational beach or create sea turtle nesting habitat. In addition, the vegetated dune and sand fences would reduce the dry beach area available for recreational use. A variation of this alternative could be implemented in combination with the proposed Project if the formation of wind blown sand dunes and landward migration of sand become a problem. Since this alternative fails to meet all Project purposes, detailed evaluation of this alternative is not warranted.

2.3.10 Alternative 13 - Navigation Project Modification or Abandonment

To correct the longshore sediment transport deficit in the Project area, all inlets could be modified or abandoned. Removal or modification of jetties, sand transfer facilities, and channel alignments, are under consideration through the State of Florida Erosion Control Program. However, substantial modifications or abandonment of inlets is unlikely in the short-term and the potential benefits of such actions in the Project area are speculative at best. Since this alternative fails to meet all Project purposes, detailed evaluation of this alternative is not warranted.

2.3.11 Alternative 14 - Beach Fill with Periodic Nourishment Stabilized by an Offshore Breakwater

The construction of breakwaters or reefs offshore in the Project area in association with beach nourishment could potentially reduce periodic nourishment quantities needed to maintain a protective and recreational beach fill. In some conditions, such structures can reduce the amount of wave energy reaching the shoreline in their lee. Typically, sand can be expected to collect behind the breakwater in a formation called a “partial tombolo” if the breakwaters are of sufficient size and are effective in decreasing wave energy and the rate of annual erosion. In some cases, these structures can thereby decrease the annual renourishment requirements. This alternative does not warrant detailed evaluation because of the additional cost of the breakwaters. In addition, adverse environmental impacts to turtle nesting could occur.

2.3.12 Alternative 15 - Beach Fill with Periodic Nourishment and Hurricane Surge Protection Berm

This alternative would help protect the shoreline from storm damages by reducing high hazard coastal flooding areas to general still water flooding areas. It is technically possible to construct a hurricane surge protection berm designed to prevent damages from hurricane-induced surges and wave runup and provide a relatively high degree of protection for the oceanfront structures. Design of an effective berm would require modification of the project design criteria and a detailed analysis of hurricane surge levels expected in the project area. The preferred alternative is designed to provide protection to upland structures under a 15 year storm conditions and accomplishes the project purpose without the necessity for a berm. Consequently, the addition of a berm is not economically justifiable in light of the project purpose. In addition, such a berm would not be aesthetically pleasing and could potentially interfere with marine turtle nesting and public use of the beach. This alternative does not warrant detailed evaluation.

2.3.13 Alternative 16 - Feeder Beach

This concept entails utilizing fill from offshore borrow areas, sand transfer plants, and truck hauls to provide for economical placement of material where it will nourish downdrift shores due to the predominate direction of littoral drift. This alternative can directly place sand into the littoral system but does not provide adequate beach for recreation and storm protection and does not fulfill the Project purpose and need. Detailed evaluation of this alternative is not warranted at this time.

2.4 Alternatives Not Within Jurisdiction of the Lead Agency

This section describes alternatives that may to some extent fulfill the Project purpose and need but which are beyond the jurisdiction of the lead agency to permit or authorize. These “extra-jurisdictional” alternatives are generally within the authority of a local government to implement and include such measures as land use controls or limitations and restrictions on construction.

2.4.1 Rezoning of Beach Area

Rezoning of the beach area to restrict or limit future upland construction could in some areas effectively reduce the risk of storm damage to upland structures associated with shoreline retreat. In the Project area, upland development has already occurred and rezoning the area would not result in any substantial reduction in potential risks to upland property. This alternative fails to achieve the Project purpose and need.

2.4.2 Modification of Building Codes

Existing Florida building codes include structural requirements intended to minimize potential impacts to the beach-dune system and reduce building damage in severe storm events. The Project area is extensively developed and while many of the structures do not conform to current building standards, these buildings are generally exempt from existing codes except unless substantially modified. Modification of the building codes could reduce storm risks associated with the current condition of the shoreline; however, it fails to address the principle Project purposes to restore the recreational beach, create sea turtle nesting habitat, and mitigate for the disruption of longshore sediment transport by updrift structures.

2.4.3 Construction Setback Line

A construction setback line would not affect existing development and could only be effective in the unforeseeable future as buildings are razed and destroyed by storms and replaced, and

as buildings are constructed on the remaining undeveloped land. The State of Florida has established construction control lines along the shores of coastal counties and through a construction permit program, based on this line, is controlling development along Florida's coastline. Like the modification of building codes, this alternative is insufficient to achieve the Project purpose and need.

2.4.4 Construction Moratorium or No Growth Program

Assuming local interests would accept a moratorium on future construction, implementation of such a policy would have little impact on the level of storm risk associated with the current erosion affecting the Project area and would not achieve the Project purpose or need relative to the recreational beach or sea turtle nesting habitat. More importantly, a no-growth program would be ineffective in this area since the majority of the area has already been developed. This alternative is currently insufficient to fulfill the Project purpose and need.

2.4.5 Evacuation Planning

Similar to other extra-jurisdictional alternatives, improved evacuation can potentially reduce the loss of life during severe storm events and should be pursued by appropriate state and local emergency management officials. However, this alternative does not address the Project purpose or need.

2.4.6 Condemnation of Land and Structures

Local governments have the power, under certain proscribed conditions, to condemn land or structures as may be determined to be in the public interest. Removal of condemned structures can also be justified and legally undertaken under limited conditions. Assuming such a policy could be implemented in the upland areas adjacent to the Project area, and all structures could be removed, this alternative would allow the shoreline to erode until equilibrium is established. This alternative is typically considered along undeveloped shorelines, but is inappropriate in this case because of the extensive development of the upland Project area.

2.4.7 Relocation or Retrofit of Structures

The relocation of the structures would allow the area to continue to erode and the land in this area would be lost until an equilibrium shoreline is reached. However, most structures within the area cannot be economically moved from the area that would be lost. In addition, implementation of this alternative would result in the loss of valuable recreational beach and would necessitate the condemnation of the land and structures in highly developed areas. This

alternative is not viable. Flood proofing of existing structures and regulation of flood plain and shorefront development are appropriate, but would not fulfill the Project purpose and need.

2.5 Comparison of Alternatives

Table 2.2 lists alternatives considered and summarizes the major features and consequences of the proposed action and other alternatives considered in detail. See Section 4.0, Environmental Effects, for a more detailed discussion of impacts of alternatives.

Table 2.2 Major Features and Direct and Indirect Impacts of the Proposed Action and Other Alternatives

Resource	Alternative 1– No-Action	Alternative 2- Beach Fill with Groins	Alternative 3 Beach Fill/ Renourishment
TOTAL COST	Construction - 0 - Net land losses - \$18 mil* Armoring costs - \$2.3 mil*	Initial fill - \$8.55 mil Groins - \$1.64 mil Mitigation - \$750,000 Renourishment - \$5.1 mil	Initial Fill - \$8.55 mil Mitigation - \$750,000 Renourishment - \$5.1 mil
TIDES, WAVES, CURRENTS & STORM EVENTS	No impact	Insignificant	Insignificant
SEDIMENT QUALITY	No impact	Insignificant Native beach sediment characteristics maintained.	Insignificant Native beach sediment characteristics maintained
VEGETATION	No impact	Increased storm protection to dune and beach vegetation. Seagrass beds absent	Increased storm protection to dune and beach vegetation. Seagrass beds absent
THREATENED & ENDANGERED SPECIES	This critically eroded area will continue to erode over the next 30 years. Sea turtle nesting areas would continue to decrease in area as beaches erode. Continual erosion into the dune areas during storm events may threaten endangered dune species.	No impact to manatees or whales expected. Beach fill activities could impact sea turtle nesting or hatchling success.	No impact to manatees or whales expected. Beach fill activities could impact sea turtle nesting or hatchling success.

Resource	Alternative 1– No-Action	Alternative 2– Beach Fill with Groins	Alternative 3 Beach Fill/ Renourishment
HARDBOTTOM AND REEFS	Additional nearshore hardbottom could become exposed.	Burial of some nearshore hardbottom. Temporary increase in turbidity and sedimentation rates over nearshore hardbottom communities. A 400-ft buffer zone in which dredging is prohibited will be maintained to avoid impacts to offshore reef areas. Groins will provide additional habitat for displaced communities.	Burial of some nearshore hardbottom. Temporary increase in turbidity and sedimentation rates over nearshore hardbottom communities. A 400-ft buffer zone in which dredging is prohibited will be maintained to avoid impacts to offshore reef areas. No net adverse or significant impact on hardbottom communities.
FISH AND WILDLIFE RESOURCES	No impact	Temporary impact on benthic organisms at beach fill construction site. Habitat improved with construction of groin and mitigation reef.	Temporary affect on benthic organisms at beach fill site. Habitat improved with construction of mitigation reef.
ESSENTIAL FISH HABITAT	No impact	Direct impact to hardbottom habitat. Minimal indirect impact. Burial of 3.1 acres of ephemeral hardbottom. Temporary displacement of fishes from nearshore areas during dredging and fill placement, temporary reduction of water quality due to turbidity during dredging operations and temporary decrease in primary productivity until completion of nourishment. Construction of the mitigation reef prior to nourishment will offset these impacts and create habitat more productive than the nearshore ephemeral habitat impacted by the Project.	Direct impact to hardbottom habitat. Minimal indirect impact. Burial of 3.1 acres of ephemeral hardbottom. Temporary displacement of fishes from nearshore areas during dredging and fill placement, temporary reduction of water quality due to turbidity during dredging operations and temporary decrease in primary productivity until the completion of nourishment. Construction of the mitigation reef prior to nourishment will offset these impacts and create habitat more productive than the nearshore ephemeral habitat impacted by the Project.

Resource	Alternative 1– No-Action	Alternative 2– Beach Fill with Groins	Alternative 3 Beach Fill/ Renourishment
COASTAL BARRIER RESOURCE AREAS	There are no designated Coastal Barrier Resource Act units located within or adjacent to the Project Area.	There are no designated Coastal Barrier Resource Act units located within or adjacent to the Project Area.	There are no designated Coastal Barrier Resource Act units located within or adjacent to the Project Area.
WATER QUALITY	No impact	Minimal and temporary impacts to water quality due to increase in turbidity and suspended sediments near the borrow and beach fill area.	Minimal and temporary impacts to water quality due to increase in turbidity and suspended sediments near the borrow and beach fill area.
HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE	No impact	No impact	No impact
AIR QUALITY	No impact	Construction equipment exhaust emissions add temporary and insignificant levels of pollutants.	Construction equipment exhaust emissions add temporary and insignificant levels of pollutants.
NOISE	No impact	Temporary increase in noise during construction from onshore bulldozers and booster pumps, offshore dredge, and clam bucket on dredge during stone placement.	Temporary increase in noise during construction from discharge pipe and booster pumps, onshore bulldozers, and offshore dredge.
AESTHETIC RESOURCES	Negative impact. Continued erosion will diminish the recreational beach and natural vegetation and habitat found on the beach.	Provides for an extended beach width for public recreation and upland vegetation.	Provides for an extended beach width suitable for public recreation and upland vegetation.
RECREATIONAL RESOURCES	Negative impact. Continued erosion will likely expose additional nearshore hardbottom making beach unsuitable and unsafe for public use.	Beach use will be temporarily impacted during construction. Temporary turbidity may degrade diving and snorkeling around borrow and nourishment areas. Groin boulders will provide additional snorkeling opportunities in the future.	Beach use will be temporarily impacted during construction. Temporary turbidity may degrade diving and snorkeling around borrow and nourishment areas. Mitigation reef will provide additional diving and snorkeling opportunities in the future.

Resource	Alternative 1– No-Action	Alternative 2– Beach Fill with Groins	Alternative 3 Beach Fill/ Renourishment
HISTORIC PROPERTIES	No impact.	No impact. Buffers have been established to avoid impacts to detected magnetic anomalies in borrow areas III and IV in coordination with SHPO (see section 4.6).	No impact. Buffers have been established to avoid impacts to detected magnetic anomalies in borrow areas III and IV in coordination with SHPO (see section 4.6).

* Based on 15 year project.

2.6 Mitigation

The Preferred Alternative, Alternative 3, results in direct burial of a total of 3.1 acres of nearshore hardbottom. The persistent nature of this feature is an indicator of the severity of the erosion in this area. There is also significant movement of sand throughout the nearshore area and variability in the specific configuration of exposed rock areas. As a result, the ephemeral rock configurations are characterized primarily by opportunistic fouling communities. The applicant proposes to construct 3.1 acres of artificial reef constructed primarily of limestone boulders to compensate for burial of nearshore hardbottom in the Project area. Appendix E, Mitigation Reef Plan and Monitoring Program, outlines the proposed mitigation method, technique, and area based on the Project permit issued by FDEP. The final mitigation plan would be developed in coordination with the FDEP, federal resource agencies, Palm Beach County DERM, and the USACE.

Borrow area design will ensure sufficient buffer areas (presently planned at 400 feet to 524 feet west of offshore hardbottom) to avoid impacts from turbidity, sedimentation and mechanical damage on offshore hardbottom communities. Precision positioning of equipment, with a Geographic Positioning System (GPS), will aid in avoiding sensitive areas. Section 4.27 Environmental Commitments (Mitigation), discusses other procedures that will be implemented to avoid or minimize potentially adverse environmental impacts.